PATENT SPECIFICATION

DRAWINGS ATTACHED

874,277

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COMPLETE SPECIFICATION

An Improved Method of Cooling Goods Packed in Containers

I, EUGEN WILBUSHEWICH, of Rotelstrasse 61, Postfach Zurich 23, Switzerland; an Israeli citizen, do hereby declare the invention for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement: —

The invention relates to an improved method for the purpose of cooling goods, such as foodstuffs, packed in containers, to a sufficiently low temperature at which they may be stored without significant deterioration. Examples of such goods include egg yolk, fruit juices, purees of berries, citrus fruits, tomatoes and apples, vegetables, meat or milk products.

It is known for this purpose to cool down the goods stacked on conveyors in a wind tunnel with a stream of air at very low temperature, for example $-40°$ C. This method requires an involved and expensive equipment and, owing to the poor heat conducting quality of air it also takes a relatively long time; for example, approximately 60 hours for cooling egg yolks, packed in $25 \times 25 \times 35$ cm, containers, down to $-18°$ C.

It is also known to place the cans containing the goods into a high-concentrated deep-cooled brine solution. However, there will always adhere to the cans residual droplets which in time will corrode through the wall and give rise to contamination of the wares. This method, too, requires much space and complicated operation.

The methods formerly used for this purpose, moreover, have been protracted owing to the comparaitvely low rate of heat transfer between the containers and the source of refrigeration employed. The object of the present invention therefore is to improve the rate of heat transfer in order to expedite the rate at which the goods are cooled to the required temperature.

Accordingly, the invention provides a method of cooling goods packed in a container, consisting in arranging the container in closely spaced relationship to a cooling element, establishing thermal contact between the container and said element by means of a film of liquid having a thermal conductivity substantially greater than that of air, cooling said element until the said liquid is frozen and until the temperature of said goods is reduced to a required value melting the frozen liquid and removing the container away from said element.

According to a preferred feature of the invention, the liquid used to establish thermal contact between the container and the cooling element is water which is frozen in the course of the cooling period.

The containers may be cooled singly or in stacks, and a plurality of containers may be arranged side by side in closely spaced relationship to the cooling element. The containers may be closely surrounded by a housing for confining the liquid, and the housing may be shaped to conform to a particular arrangement of containers. The combined effects of the close proximity between the container or containers and the cooling element and the comparatively high thermal conductivity of the liquid filling the narrow space between them ensures a high rate of heat transfer, with the result that the contents of the containers are rapidly cooled. The use of water according to the preferred feature of the invention is particularly advantageous since in addition to its high thermal conductivity, it freezes during the cooling period to form ice the thermal conductivity of which is considerably higher even than that of liquid water. Furthermore, thermal contact is maintained owing to the expansion of water on freezing.

Whilst the use of water is preferred, other liquids having a substantially higher thermal conductivity than that of air may be used

in accordance with the invention. The liquid chosen should be substantially chemically inert to the container material, in order to minimise corrosion during cooling or storage, and possible contamination of the contents of the container. Where a housing surrounding the container or containers is employed, the cooling element of the housing may comprise a jacket surrounding the housing, and/or a core extending into the interior of the housing, refrigeration liquid being evaporated in the jacket and core to cool the container in the housing.

Additional cooling means may be provided comprising cooling cores extending into the liquid filling the residual space, or into the containers themselves if these are open during the cooling process. Egg yolks or meat pastes filling open containers measuring 25×25×35 cm. may be cooled to −18° C. in as little as 2 hours according to the method of the invention, by the use of a housing fitted with an evaporation jacket and an evaporation core extending into the contents of each container.

The invention will now be described in more detail with reference to the accompanying drawings which illustrate by way of example, apparatus for carrying out the method of the invention.

In the drawings:—

Fig. 1 is a vertical section of part of a preferred arrangement, showing a container being cooled in a housing.

Fig. 2 is a similar view showing a cooled container being discharged from the housing.

Fig. 3 is a horizontal section of an arrangement including cooling elements extending into the liquid filling the residual space between adjacent containers in the housing.

Fig. 4 is an illustration of a container provided with an axial bore, and Fig. *4a* is a vertical section through such a container with a cooling element comprising an evaporation core extending through the bore.

Fig. 5 is a diagram of a tubular housing and a chute having a release mechanism for discharging containers from the housing.

Fig. 6 is a plan view of three housings for accommodating cylindrical containers, the housings being provided with a common refrigerant evaporation jacket.

Fig. 7 is a plan view of a number of housings of the kind shown in Fig. 6 assembled in an insulated block.

Fig. 8 is a general view of two housings for rectangular containers enclosed in a common evaporation jacket.

Fig. 9 is a line diagram of a battery of coolers operating in accordance with the invention, and

Figs. *9a* to *9e* respectively show diagrammatically the multi-way valve of a unit in the battery and its various settings at successive stages of the operational cycle.

Referring to Figs. 1 and 2, a housing 6 of round or prismatic cross section comprises an inner wall *8a* and an outer wall *8b* spaced therefrom to provide a hollow jacket 8 in which refrigeration liquid may be evaporated to cool the housing. In Figs. 3 and 5 the outer wall surrounds only one housing, but in alternative embodiments as for example shown in Figs. 1, 2, 6, 7 and 8 the outer wall may surround several housings arranged side by side. The inner wall *8a* is arranged to conform closely to the walls of the container A to be cooled. A cooling core 7 comprises concentric tubes *7a* and *7b* and extends substantially to the base of the housing, outer tube *7b* being closed at its lower end to permit the evaporation of refrigeration liquid therein.

A suitable refrigeration unit is connected to supply refrigeration fluid to the inner tube *7a* and suction to the outer tube *7b*, and to the jacket 8 via pipe *7c*. A pipe *8c* permits refrigeration fluid to be admitted to or withdrawn from the base of the jacket 8.

The base of each housing comprises a hinged flap 9 of aluminium or other material of good thermal conductivity. In an arrangement comprising a plurality of housings, these may be interconnected by means of channels *6a*.

Each container A which may contain for example egg yolk, may be made from metal, plastic or paper sheet, coated externally with material such as ski laquer to which ice has little adhesion, and is pushed up through the bottom of the housing 6 and supported therein by a dimple *9a* in the upper face of the flap 9 which is locked in position by a latch not shown. In this position the container is permitted only a few millimetres side play, and the core 7 extends into the contents of the container substantially to the bottom thereof. The base of the housing may alternatively be sealed by initially freezing the flap 9 previously wetted for the purpose, to the lower part of the housing, or the flap may be temporarily held in position until the wetted container is frozen to the sides of the housing. When the container is secured in the housing, the residual space 68 between it and the inner wall of the housing is filled with water, and cold refrigeration liquid is supplied through line *7a* and through line *8c* to fill the jacket, and suction applied to the line *7b*. The refrigeration liquid partially evaporates in the core 7 to cool the contents of the container radially outwards but some refrigeration liquid is diverted, by the suction applied, from the core 7 via pipe *7c* to the jacket 8 in which further evaporation occurs to cool the container and its contents radially inwards through the water which is confined in the residual space described, and which rapidly freezes. In solidifying, the water expands to pack the residual space completely without forming air voids, thereby ensuring

enhanced heat transfer as a result of the greater thermal conductivity of ice.

When the container and its contents have cooled to the rejuired temperature, the core 7 and jacket 8 are arranged in series, and hot fluid is supplied to the core 7 through the inner tube 7*a*, passes through pipes 7*b* and 7*c* into the jacket 8 forcing the liquid therein to leave through the pipe 8*c*, until the resultant thawing process releases the flap 9 (previously unlatched) and the container A drops out of the housing 6 under its own weight as shown in Fig. 2, the small stump of ice 6*b* formed in the channel 6*a* being insufficient to retain the container. In Fig. 2 the film of ice surrounding the container is for purposes of illustration shown thicker than is actually the case in practice, so that any ice not completely melted away from the container after its release from the housing 6, is only paper thin. The released containers may be received on a table mounted on springs or similar shock absorbers, or a curved chute may be provided to receive the containers discharged from the housing, see Fig. 5.

Fig. 3 illustrates an arrangement in which the cross-section of the interior of the housing 6 is substantially filled by a closely assembled group of four rectangular containers A, cooling being effected by evaporation of refrigerant in the jacket 8 surrounding the housing and also in the cooling cores 7 which extend vertically into the residual space 68 in the housing 6 between the containers A, which space is filled with water before the cooling process.

Closed containers having an axial bore such as illustrated in Fig. 4 are particularly suitable for use in the cooling method according to the invention since they may be stacked one above the other, the axial bore B of each container A being threaded over a core 7 as shown in Fig. 4*a*. The bore of each container may then be filled with water and the container contents cooled in the manner described.

The water may be retained in the bores by first freezing the core to the lowermost container, or the containers may be stacked in a closely fitting housing, which may also be provided with a cooling jacket, the housing being substantially filled with water.

In the arrangement shown in Fig. 5, the lowermost of a stack of filled, closed containers in a housing 6 is wetted and temporarily retained in the housing 6 by extension of the spring loaded catch 22*a* secured at the upper end of the curved chute 22, until by evaporation of refrigeration liquid in the annular jacket 8 the container is frozen to the housing to seal the housing and support the stack. The catch 22*a* may then be retracted by the spring 22*b*, the residual space 68 in the housing filled with water, and the cooling continued until the temperature of the contents of the containers is lowered to a required value. Hot fluid is then circulated in the jacket 8 and the resultant thawing automatically releases the containers A from the housing to the chute 22 below. The column of released containers may be separated by the knife-edge tip of the catch 22*a* and/or the deflection caused by the chute. A coating of ski-lubricant on the containers facilitates their separation and the removal of ice from the containers.

In the arrangement shown in Fig. 6, three cylindrical housings for containers are provided with a common jacket 8 of which the outer wall 8*b* is arranged closely to as much of the perimeter of each housing as possible, in order that the ratio of the cooling surface of the jacket to its volume is a maximum. For this reason, the particular grouping of housing shown is preferred for use with cylindrical housings having a common evaporation jacket. An inlet tube 8*d* for the admission of refrigeration fluid to the jacket 8 extends in the space between the housings, substantially to the bottom of the jacket 8 to reduce further volume of the jacket.

Fig. 7 shows a group of jacketed housings of the kind illustrated in Fig. 6 supported in a block of suitable thermal insulation 88.

Fig. 8 is an illustration of a twin housing arrangement in which the two rectangular housings 6, are fixed in a common jacket, which is fitted with a pipe drainage 8*c* at its base and concentric refrigerant delivery and suction pipes 8*d* and 8*e*, of which the former extends into the jacket substantially to the base thereof. Rectangular, closed containers A previously filled with foodstuff are stacked in each housing, which is sealed in the manner already described, the housings are filled with water, and cold refrigeration liquid admitted to the jacket through pipe 8*d* is evaporated by applying suction through pipe 8*e* to cool the contents of the containers, which are subsequently discharged from the housings when the temperature of the contents has fallen to a required temperature.

Referring to Fig. 9, each unit of a cooling battery for cooling filled, open containers comprises an upright housing 6 provided with a cooling core 7 and jacket 8, a tilting bottom flap 9, a jacket base pipe 8*c*, a water valve 30 for supplying water to the housing, and a multi-way valve 10 for controlling the flow of refrigeration fluid to and from the jacket 8 and cooling core 7, which are interconnected by pipe 7*c*. A discharging mechanism 21 may be associated with each unit, to deliver the cooled containers to a conveyor 32.

A compressor 17 driven by a motor 24 delivers refrigeration fluid to an oil separator 18 and condenser 16 which supplies cold refrigeration liquid to common line 1, and also

delivers hot refrigeration fluid through a branch line to common line 4. The suction side of the compressor 17 is connected with common line 2 through a liquid separator 19 which supplies refrigeration liquid to common line 3. A refrigeration liquid receiver 14 is in turn connected to a further common line 5. The liquid receiver 14 is connected to the liquid separator 19 via a float value 15.

Fig. *9a* shows the connection effected between the common lines and each unit by the ports of the multi-way valve 10 which is associated with the unit, and the relative positions of the four spaced ducts through the rotatable plug of the valve 10. Figs. *9b* to *9e* show in turn the respective positions of the tappings in relation to the ports of the valve 10 corresponding thereto which are obtained in successive stages of the operational cycle of each unit by rotating the plug of the valve in the direction of the arrow in Fig. *9a* through 90° at each stage.

A branch from line 1 includes an expansion valve *11a* and serves to cool a water tank 13 for supplying water via tank 12 to the housings, through valves 30, the refrigeration fluid used being returned to the liquid separator 19 through the suction line 2.

The operational cycle may be effected independently in each unit and is as follows. A housing is loaded from the bottom with a filled, open container A and the flap 9 held in the closed position by a catch not shown to support the container A on the dimple *9a*, when the core 7 extends into the container contents substantially to the bottom of the container. The flap 9 may be wetted and frozen to seal the bottom of the housing in a preliminary cooling operation, after which the catch may be released. The space 68 remaining in the housing is then filled almost to the top of the container A with precooled water from the tank 12 through valve 30.

From the stop position shown in Fig. *9e* in which the unit is effectively isolated, the plug of multi-way valve 10 is rotated in the direction of the arrow shown in Fig. *9a* through 270° to the liquid return position shown in Fig. *9d*, in which the outer tube *7b* of the cooling core and thus the jacket 8, via line *7c*, is connected to the common suction line 2. At the same time the base pipe *8c* is connected to the liquid separator 19 through common line 3 and to the liquid receiver 14 through common line 5 until the jacket 8 is substantially filled to a predetermined level with refrigeration liquid chiefly from the receiver 14, after which the plug of valve 10 is once more rotated in the same direction through 180° to the freezing position shown in Fig. *9b*. In this position the suction to the core 7 and jacket 8 continues, the liquid receiver 14 is isolated from the jacket 8, the liquid level in which is however maintained by a common line 3 from the liquid separator 19, and cold refrigeration liquid is also admitted from common line 1 through preset expansion valve 11 and the inner tube *7a* to the core 7. The rapid evaporation of refrigeration liquid in the core and jacket cools the container contents radially outwards and inwards respectively, in the latter case through the water in the space 68 which freezes rapidly.

After a predetermined interval when the temperature of the container contents falls to a required value, the plug of valve 10 is once more rotated in the same direction through 90°, to the defrosting position shown in Fig. *9c*. In this position the supply of cold liquid refrigerant from common line 1 to the inner tube *7a* of the cooling core 7 is exchanged for hot refrigeration fluid from common line 4. At the same time the outer tube *7b* and hence the jacket 8 are isolated from the common suction line 2, the base pipe *8c* is isolated from the common line 3 and connected once more to the liquid receiver 14 into which the refrigeration liquid from the jacket 8 is forced by the passage of the hot refrigeration fluid, first through the core and then through the jacket via pipe *7c*. During this stage the hot refrigeration fluid releases the core and the jacket respectively from the container contents and the housing to which they were frozen, and permits the flap 9 to be opened under the weight of the released container A which falls on to the discharge equipment 21. A restrictor plate may be fitted in line *7c* in accordance with the method described in my British Specification No. 802,593, in order to ensure that the core 7 and jacket 8 are released substantially simultaneously and in the minimum time.

Following the release of the container A, the plug of multi-way valve 10 may be rotated once more to the stop position shown in Fig. *9e*, and the operational cycle repeated. Alternatively, the defrosting stage may be immediately followed by the liquid return stage of the next cycle.

In the foregoing description, each unit comprises a single housing, but it may instead comprise a plurality of housings within a common jacket. The ducts and ports of valve 10 may be modified to connect the base pipe *8c* to the liquid receiver 14 only, during the liquid return stage.

The units of a battery shown in Fig. 8 may be phased so that heat removed from a proportion of units undergoing the freezing cycle by a refrigeration fluid may be utilized in other units undergoing the defrosting cycle.

In an alternative embodiment not shown the refrigeration liquid circuit is modified in that during the freezing cycle cold refrigeration liquid is supplied from the condenser to the housing jacket only, the core being supplied with refrigeration liquid drawn from

the jacket by the suction applied thereto through the pipe connecting the core to the jacket.

Although the above description refers to the cooling of containers, the cooling principle is eminently suitable for the general purpose of freezing water into ice blocks, and a method and apparatus for freezing a liquid, using a cooling battery similar to that illustrated in Figs. 9 to 9*e*, is described in my Divided Application No. 34010/60 (Serial No. 874,278).

WHAT I CLAIM IS:—

1. A method of cooling goods packed in a container, consisting in arranging the container in closely spaced relationship to a cooling element establishing thermal contact between the container and said element by means of a film of liquid having when frozen, a thermal conductivity substantially greater than that of air, cooling said element until the said liquid is frozen and until the temperature of said goods is reduced to a required value, melting the frozen liquid and removing the container away from said element.

2. A method according to Claim 1 consisting in arranging a plurality of containers in a group in closely spaced relationship to said cooling element, establishing thermal contact between adjacent containers in said group by means of said film of liquid, cooling said element until said liquid is frozen and melting the frozen liquid to free said containers from said element as a group.

3. A method according to Claim 1 or 2 wherein said liquid is water.

4. A method according to Claims 1, 2 or 3 wherein said liquid is confined in a housing closely surrounding said container or containers and an additional cooling is effected by an auxiliarly cooling element extending into said housing.

5. A method according to Claim 4 wherein at least one container is provided with an opening in its top and said auxiliary cooling element extends into the contents of said container.

6. A method according to any preceding claim wherein a sealing member and said cooling element are initially frozen together to retain said liquid between said container and said cooling element.

7. A method according to Claim 6 wherein said sealing member comprises a container.

8. A method according to any preceding claim wherein each container is furnished with an axial bore in which a cooling core comprising said element is accommodated.

9. A method according to any one of Claims 2 to 4 or 6 to 8 wherein a plurality of containers is stacked one upon the other.

10. A method according to any of the preceding claims wherein said cooling is effected by evaporation of liquid refrigerant in said cooling element or elements.

11. A method according to Claim 10 wherein following the cooling process, hot refrigerant is admitted into each cooling element to release each container therefrom.

12. A method of cooling goods packed in containers substantially as hereinbefore described with reference to the accompanying drawings.

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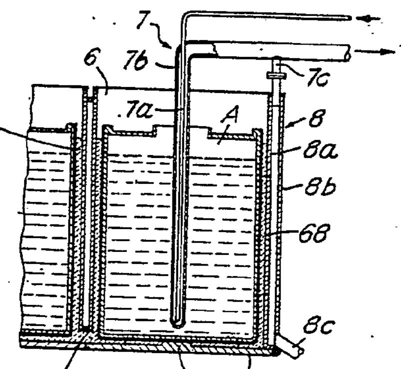

FIG. 1.

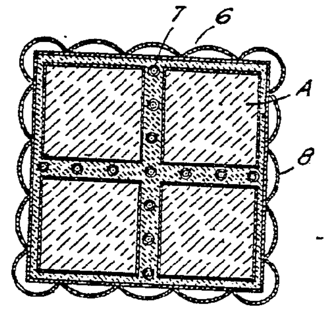

FIG. 3.

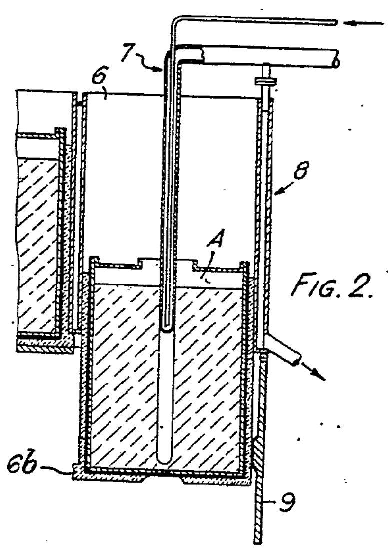

FIG. 2.

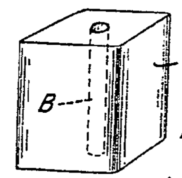

FIG. 4.

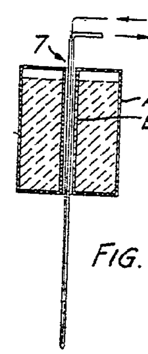

FIG. 4a.

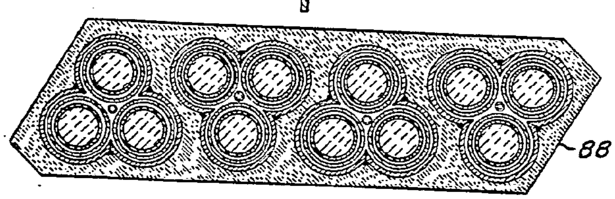

FIG. 7.

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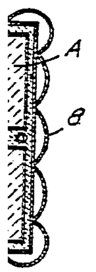
Sheets 1 & 2



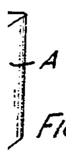


FIG. 4.

. 4a.

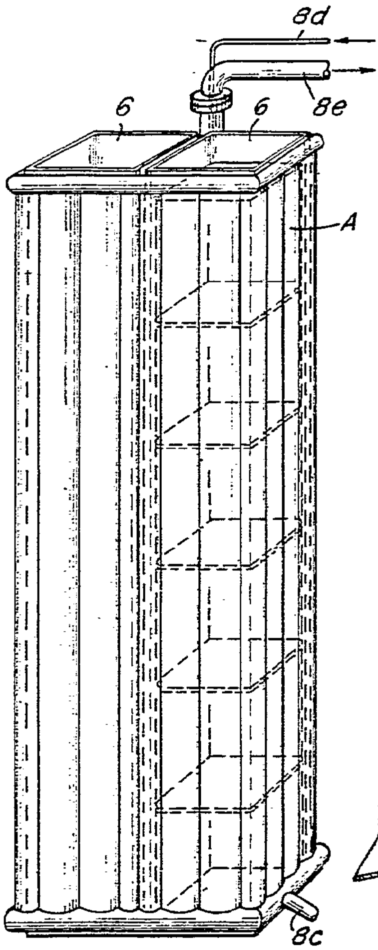


FIG. 8.

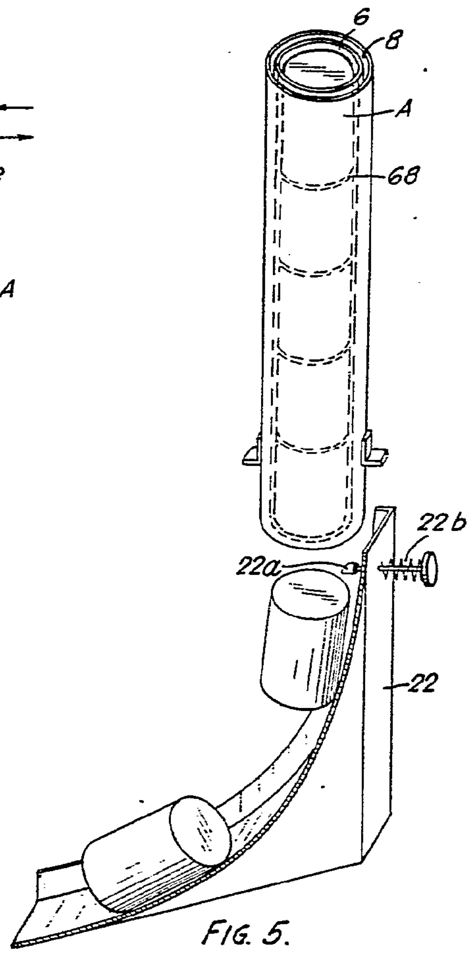


FIG. 5.

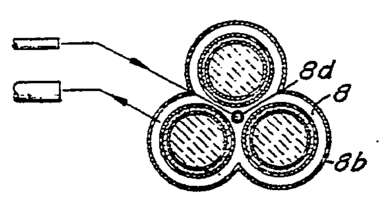


FIG. 6.

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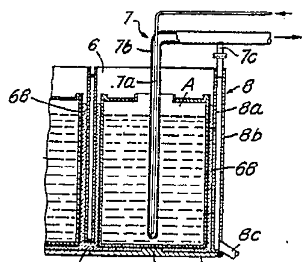

FIG. 1.

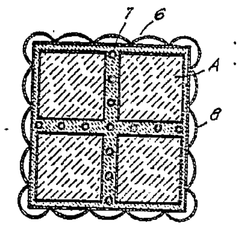

FIG. 3.

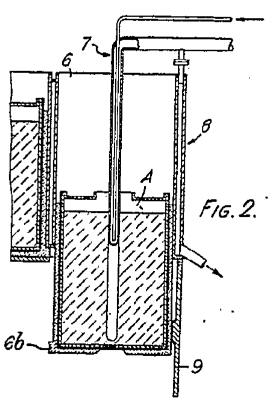

FIG. 2.

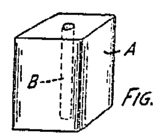

FIG. 4.

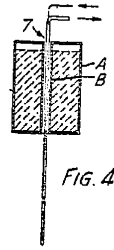

FIG. 4a.

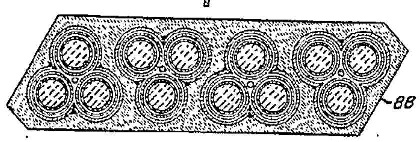

FIG. 7.

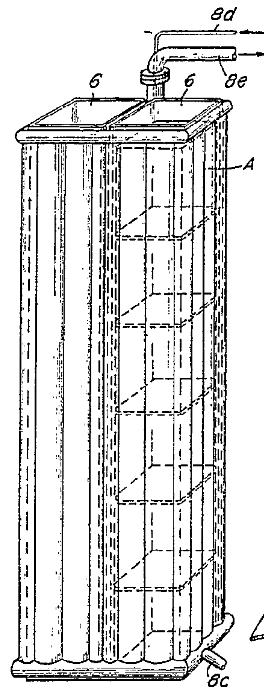

FIG. 8.

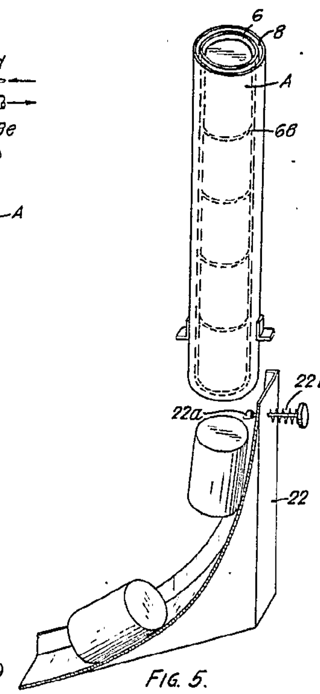

FIG. 5.

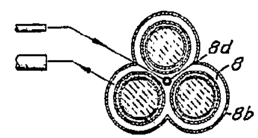

FIG. 6.

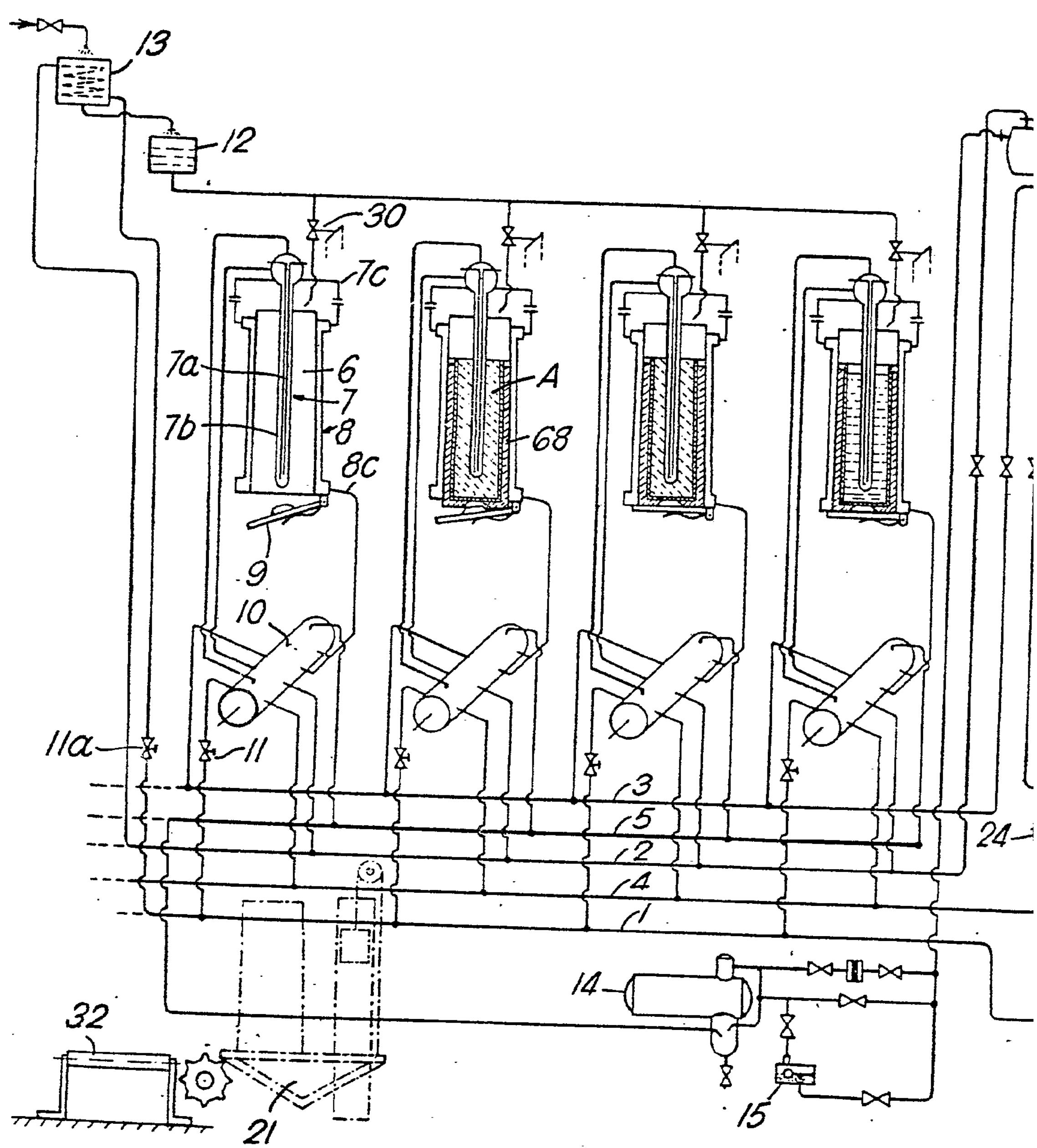

FIG. 9.

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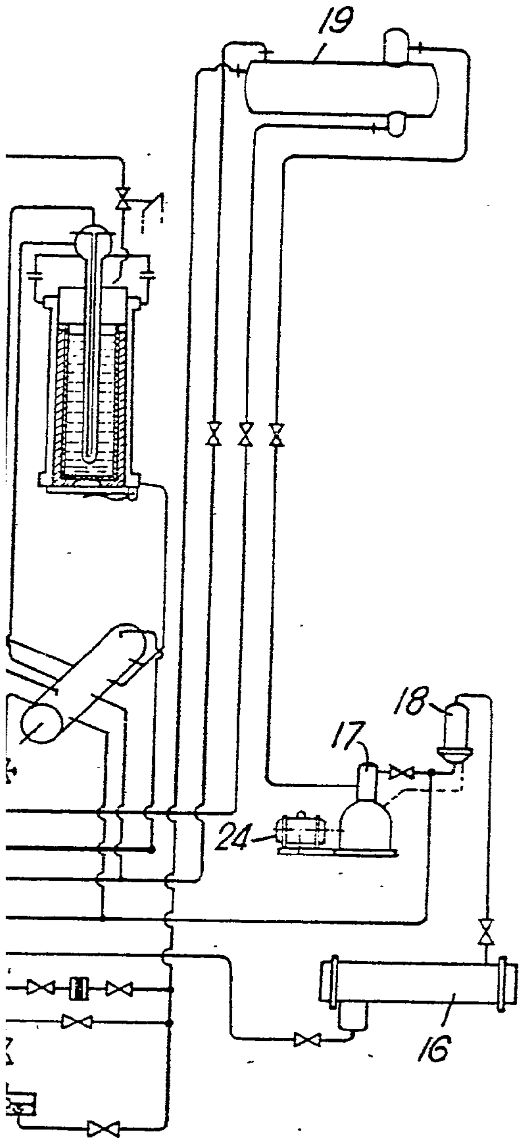

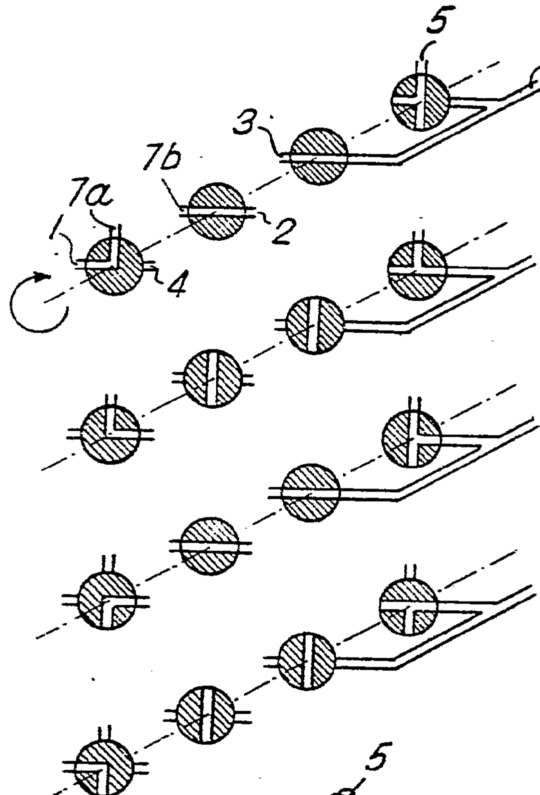

FIG. 9b.

FIG. 9c.

FIG. 9d.

FIG. 9e.

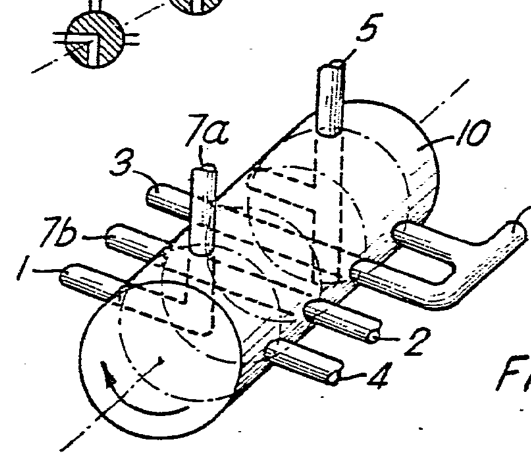

FIG. 9a.

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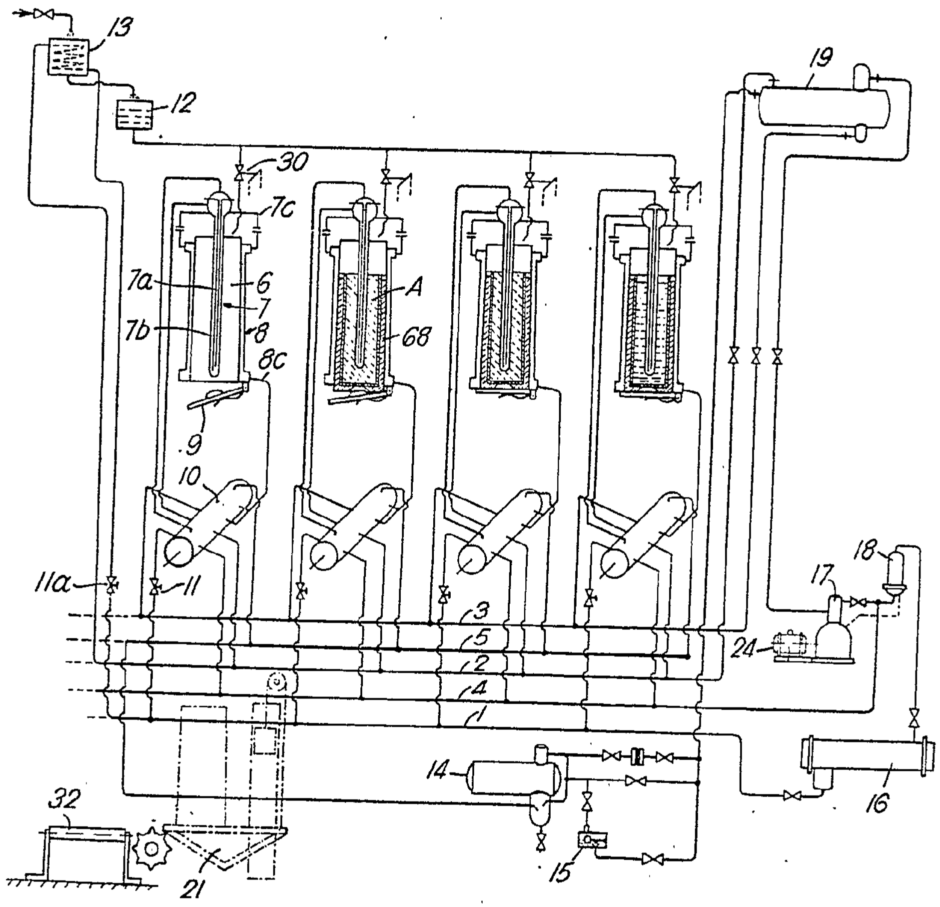

FIG. 9.

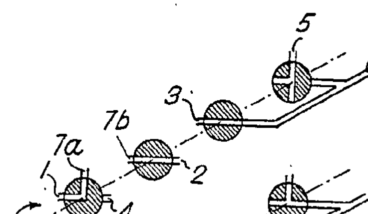

FIG. 9b.

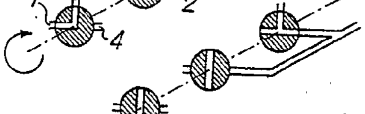

FIG. 9c.

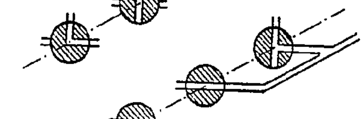

FIG. 9d.

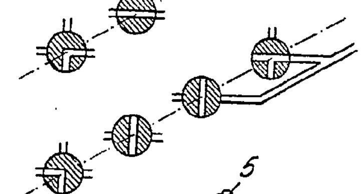

FIG. 9e.

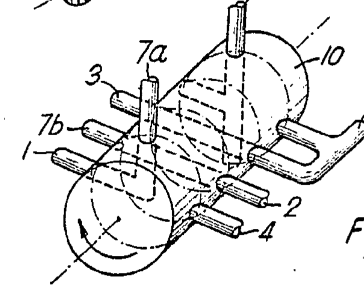

FIG. 9a.